

# Development of Novel, Optically-Based Instrumentation for Aircraft System Testing and Control, Phase I

Completed Technology Project (2007 - 2008)



## Project Introduction

We propose to develop a compact, robust, optically-based sensor for making temperature and multi-species concentration measurements in aircraft system ground and flight test environments. This system will utilize a widely tunable near infrared light source to make absorption measurements of gas constituents in the propulsion system (combustion reactant and products in the combustion zone, with accuracy from 100-1000 ppm), aircraft cabin air, and fuel tank/on-board gas generator systems. The light source will be able to continuously tune from 0.4 to 2.3 microns while maintaining a narrow bandwidth of 0.01 cm<sup>-1</sup> using a novel combination of acousto- and electro-optically controlled devices. The rapid tunability of this light source will obviate the need for dense multiplexing of multiple wavelengths as signals can be multiplexed in time while maintaining fast temporal response. Furthermore, the wide spectral bandwidth allows for the selection of the optimum absorption transitions, without regard for the commercial availability of narrow bandwidth diode lasers. The proposed instrumentation will be environmentally rugged, with the ability to withstand extreme ranges of temperature, humidity, vibration and shock conditions. Further, the system will possess auto-calibration capabilities, fast response time (few microseconds) and can be battery operated.

## Anticipated Benefits

This type of sensor can also be used to monitor the combustion efficiency in terrestrial gas turbine and high-pressure combustion systems where a rugged sensor with long operating life characteristics is needed. Also it is possible to use this sensor for real-time biological measurements as the system can also be used as a Fraunhofer Line Discriminator Spectrometer for sub-angstrom remote sensing of fluorescence emission in the Fraunhofer line wavelengths. Finally, large and complex molecules that have extremely broad absorption signatures could be fully resolved with this sensor, with application to national security sensing of weapons and explosives. There are many commercial and military applications for an accurate and rugged laser absorption system capable of acting as a temperature and/or concentration sensor. The sensor could be used in both new and retrofit commercial aircraft as a control sensor for propulsion systems, as its capabilities easily extend to a very wide-range pressure environment. The reliable and precise instrument can be used to control gas turbine combustors, afterburners, and turbine optimization. The system could also be used in aircraft fuel tanks to measure fuel vapor flammability and oxygen concentration in OBIGGS systems. Furthermore, due to the widely tunable light source, this sensor could be used to replace TDLAS sensors in any application, as there is a demonstrable advantage in system cost, complexity, and operation.



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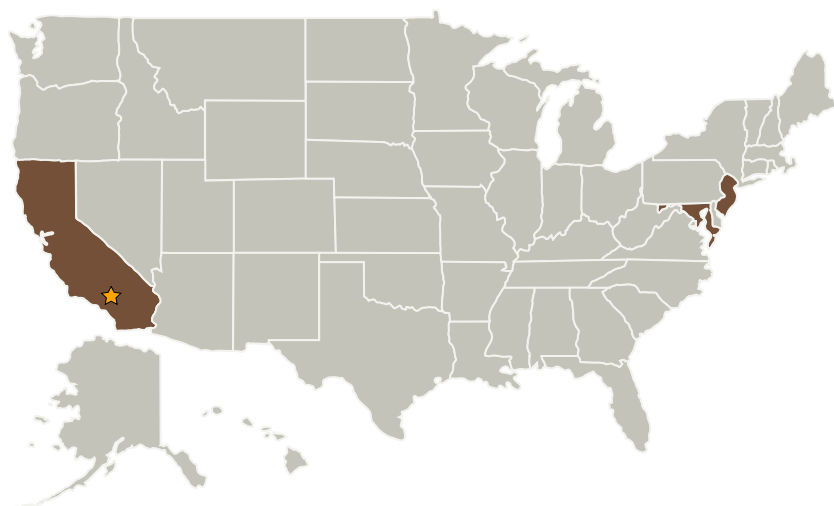
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## Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Armstrong Flight Research Center(AFRC)	Lead Organization	NASA Center	Edwards, California
Brimrose Corporation of America	Supporting Organization	Industry	Sparks, Maryland
Rutgers University-New Brunswick	Supporting Organization	Academia	New Brunswick, New Jersey

Primary U.S. Work Locations	
California	Maryland
New Jersey	

## Organizational Responsibility

### Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

### Lead Center / Facility:

Armstrong Flight Research Center (AFRC)

### Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

## Project Management

### Program Director:

Jason L Kessler

### Program Manager:

Carlos Torrez

### Project Manager:

Ross W Hathaway

### Principal Investigator:

Pranay Sinha

## Technology Areas

### Primary:

- TX17 Guidance, Navigation, and Control (GN&C)
  - └ TX17.2 Navigation Technologies
    - └ TX17.2.3 Navigation Sensors